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**Takeuchi et al.**

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(54) **BOARD-TO-BOARD CONNECTOR**

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See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

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5,395,250	A	3/1995	Englert, Jr. et al.	
7,090,508	B1	8/2006	Chen	
7,128,581	B2	10/2006	Igarashi et al.	
2008/0207014	A1 *	8/2008	Takeuchi et al.	439/74
2010/0248524	A1 *	9/2010	Miyazaki et al.	439/357

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FOREIGN PATENT DOCUMENTS

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JP	2004-055306	2/2004
JP	2007-095371	4/2007

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(2), (4) Date: **May 18, 2012**

OTHER PUBLICATIONS

(87) PCT Pub. No.: **WO2011/032106**

International Search Report for PCT/US2010/48669.

PCT Pub. Date: **Mar. 17, 2011**

\* cited by examiner

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(57) **ABSTRACT**

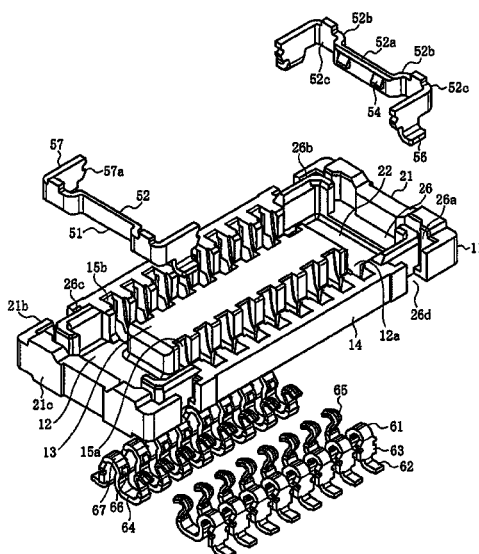
(51) **Int. Cl.**  
**H01R 12/00** (2006.01)  
**H01R 12/71** (2011.01)  
**H05K 3/36** (2006.01)

A board-to-board connector has such a configuration that at least one a first reinforcing bracket of a first connector and a second reinforcing bracket of a second connector is provided with a bent portion having a crank shape, viewed from the insertion/removal direction of the first and second connectors. Owing to such a configuration, deformation of the first reinforcing bracket and/or the second reinforcing bracket can be prevented, and a firm engagement state between the first and second reinforcing brackets is achieved. As a result, a strong removal force is required for releasing the engagement state, and a stable engagement between the first connector and the second connector can be maintained.

(52) **U.S. Cl.**  
CPC ..... **H01R 12/716** (2013.01); **H05K 3/368** (2013.01); **H05K 2201/10189** (2013.01)

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**11 Claims, 8 Drawing Sheets**



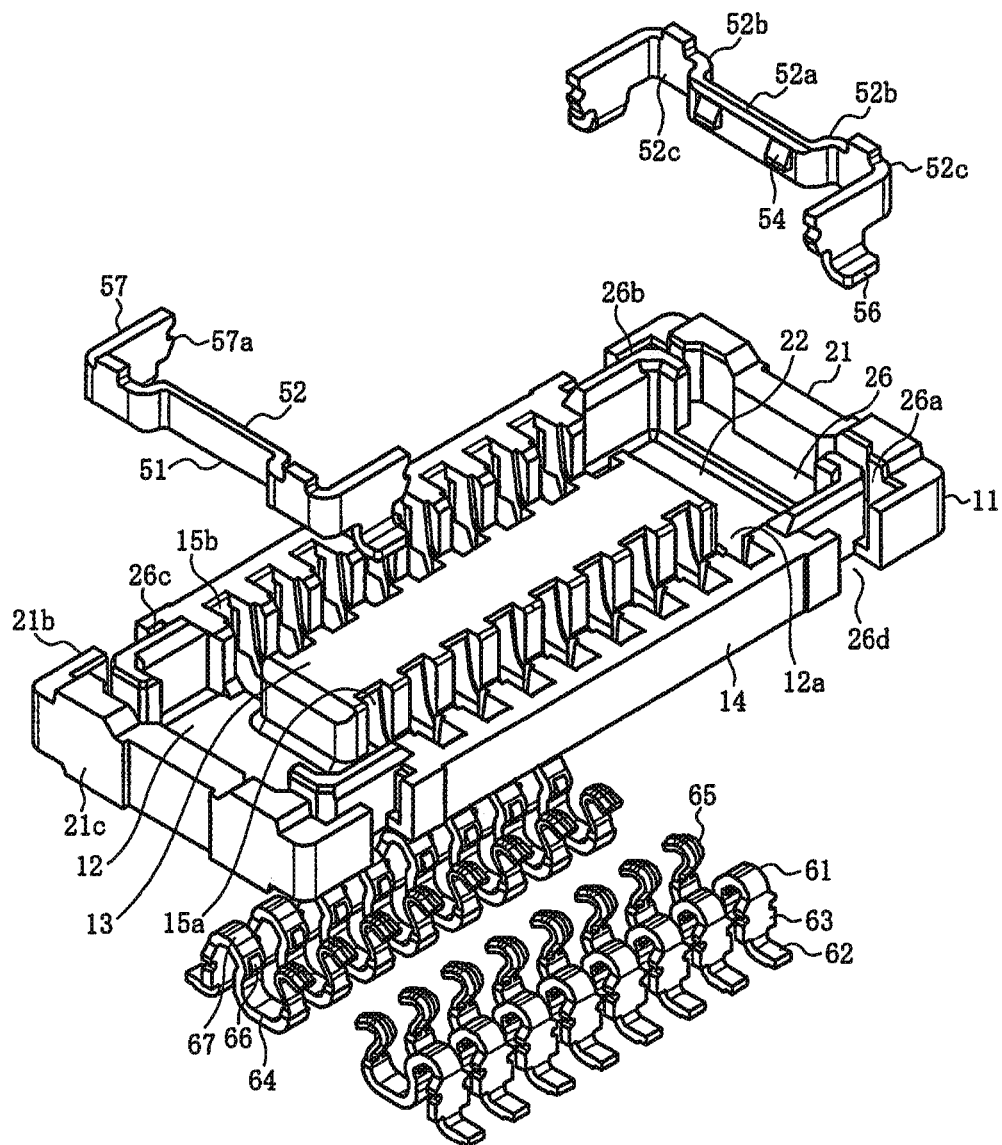


FIG. 1

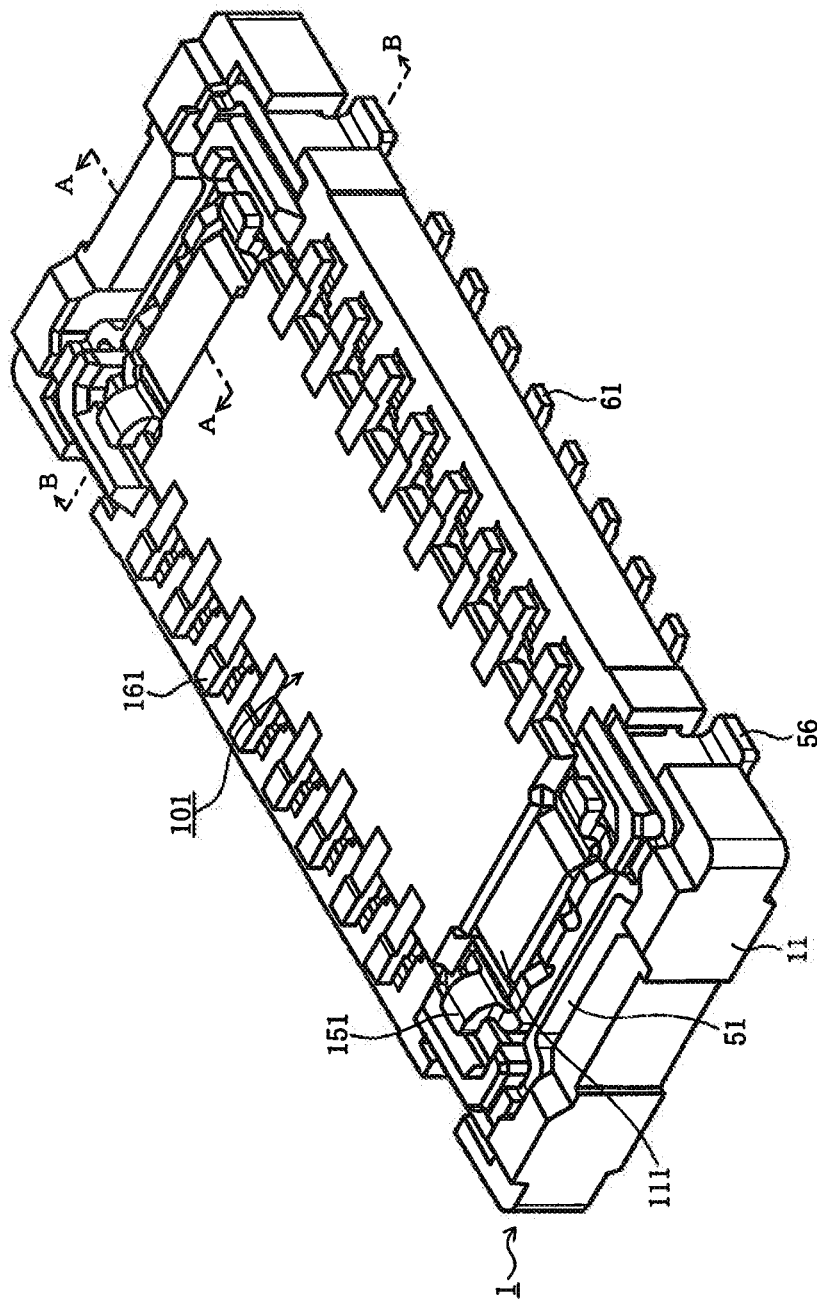
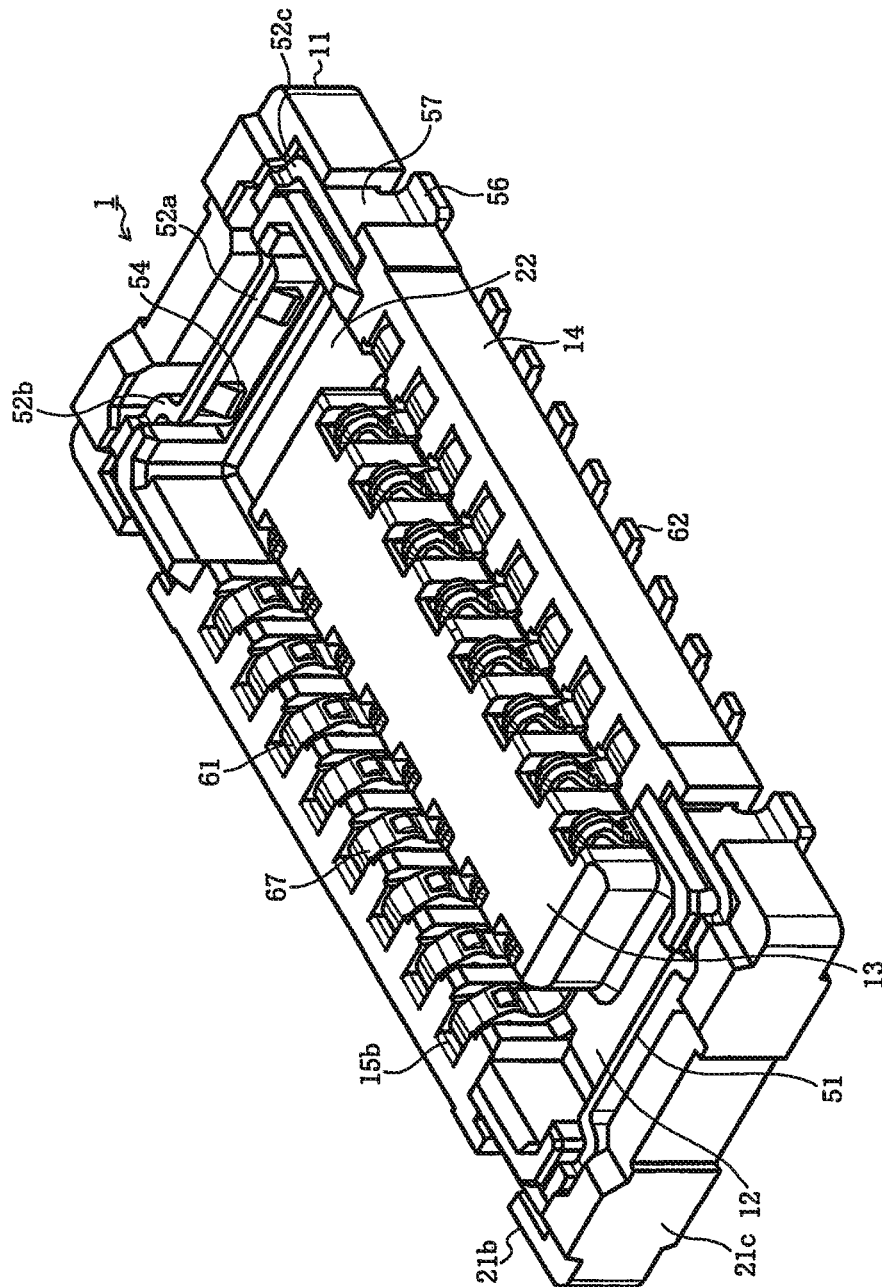


FIG. 2



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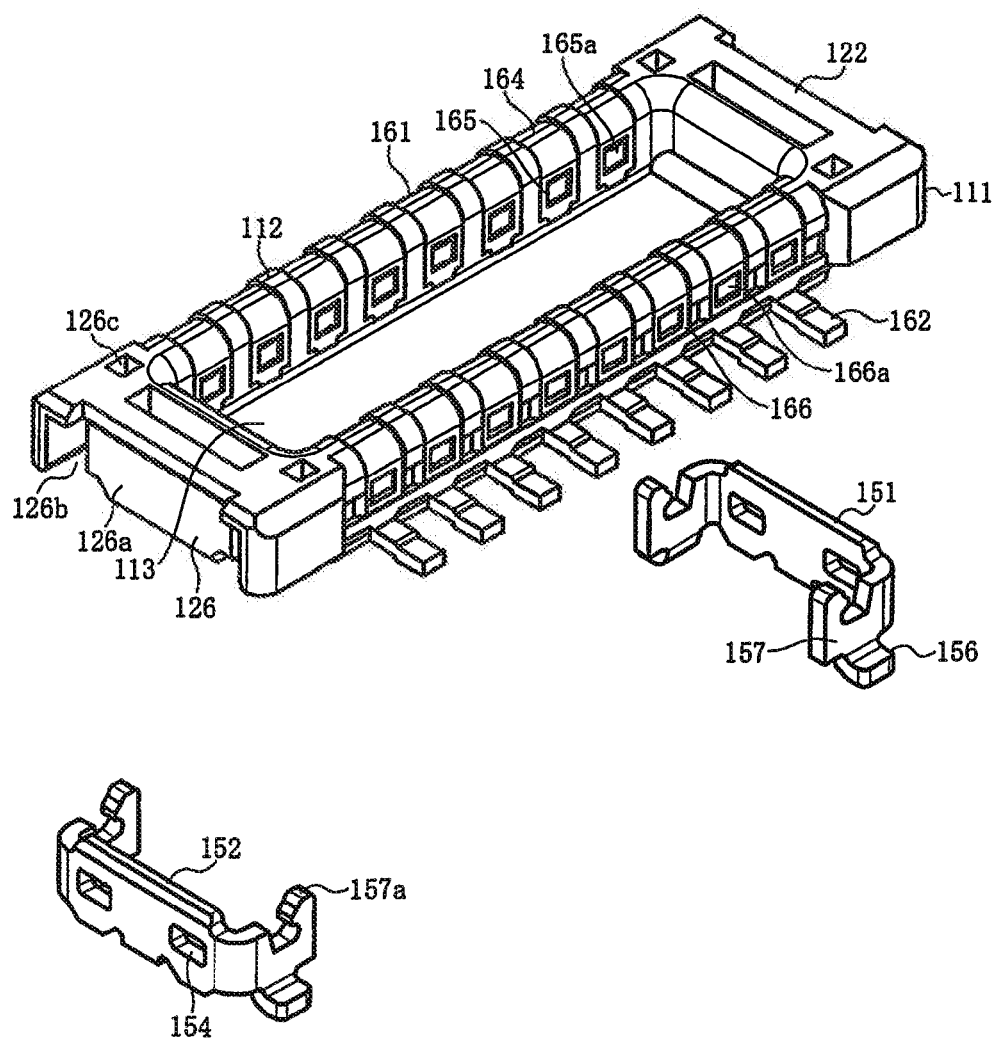


FIG. 4

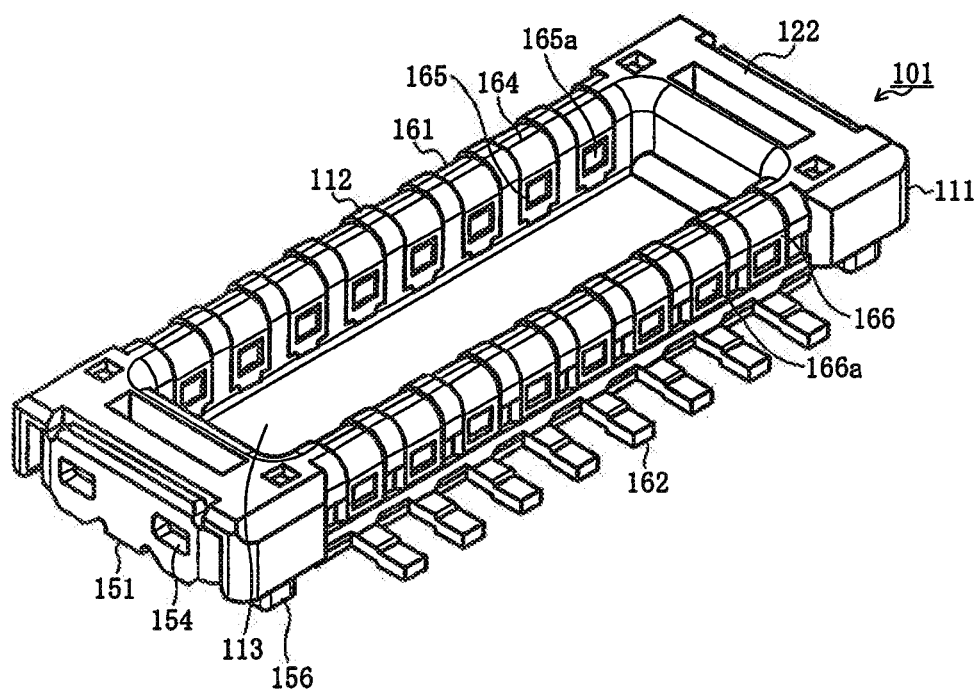


FIG. 5

FIG. 6A

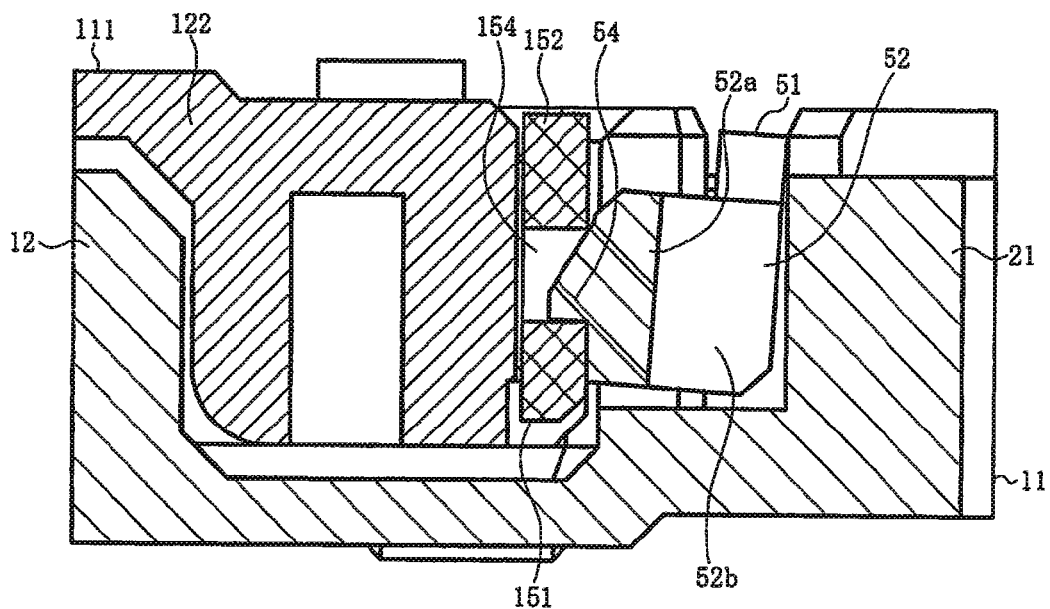
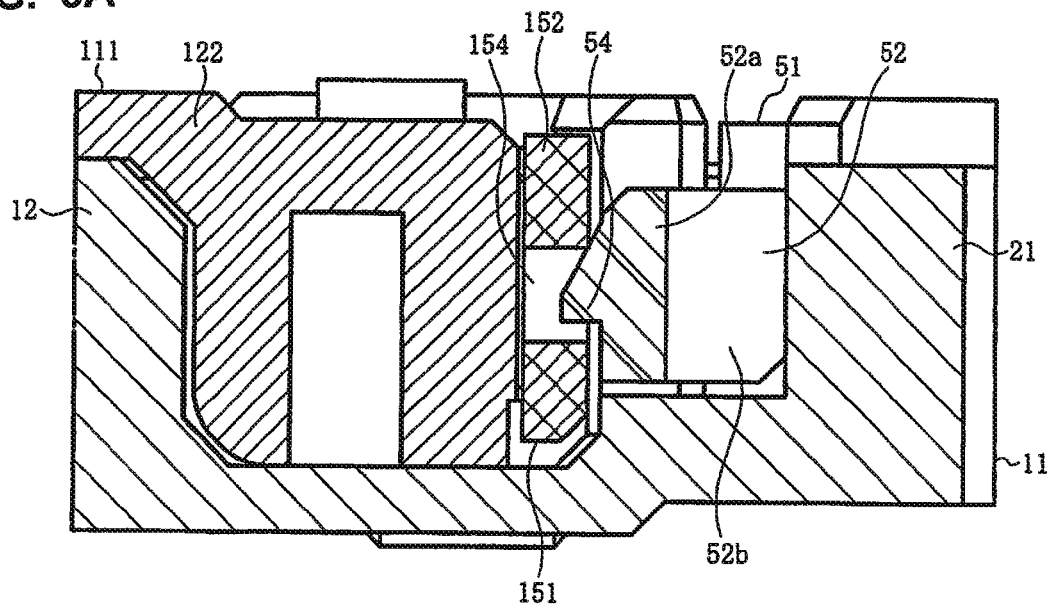


FIG. 6B

FIG. 7A

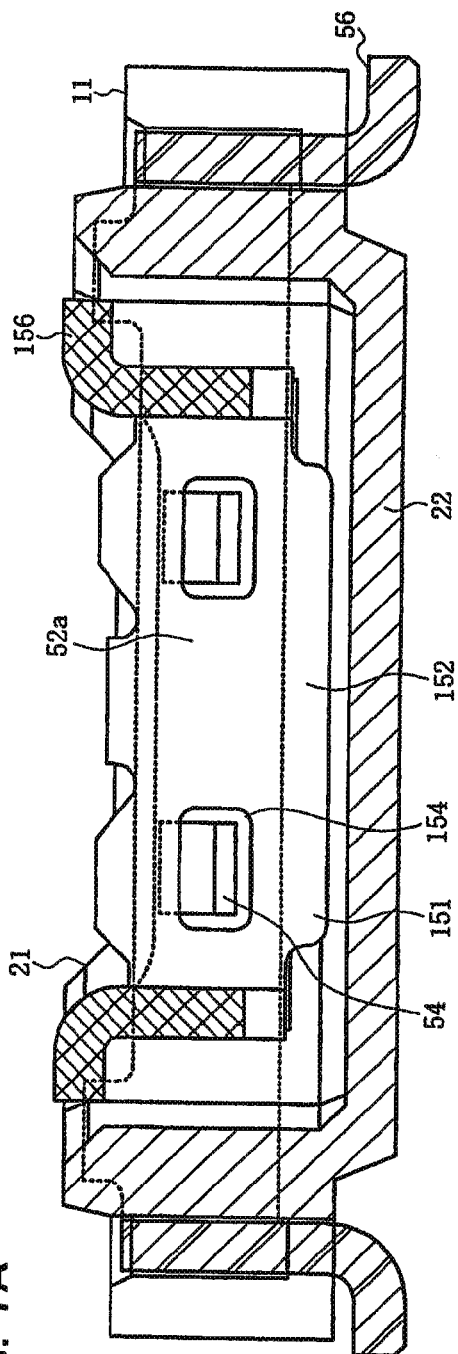
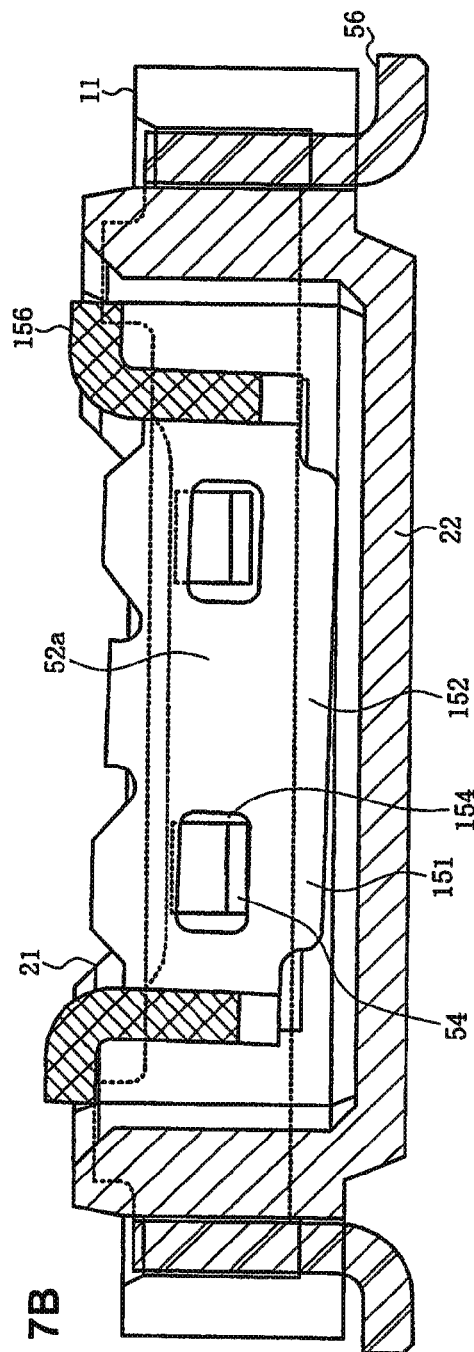
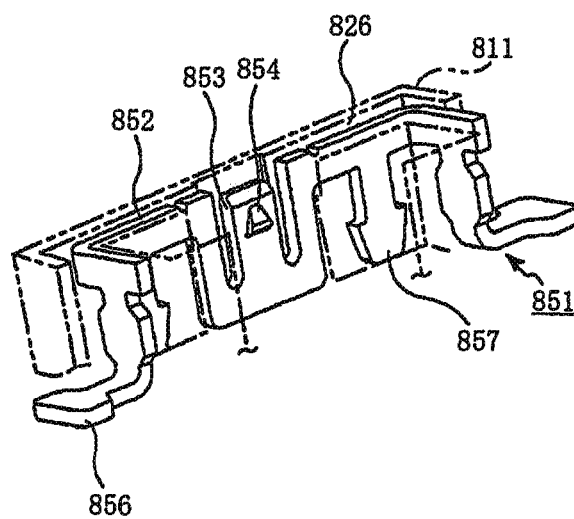
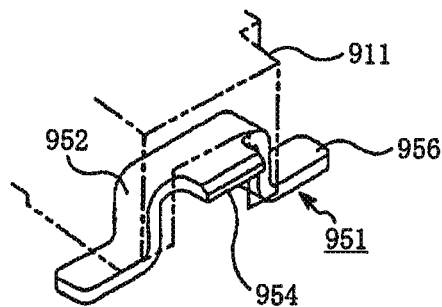


FIG. 7B







Prior art

**FIG. 8**

## BOARD-TO-BOARD CONNECTOR

## REFERENCE TO RELATED APPLICATIONS

The Present Application claims priority to prior-filed Japanese Patent Application No. 2009-210528, entitled "Board-To-Board Connector," and filed 11 Sep. 2009, the contents of which is fully incorporated in its entirety herein.

## BACKGROUND OF THE PRESENT APPLICATION

The Present Application relates generally to a board-to-board connector, and, more particularly, to a board-to-board connector having a strong removal force for releasing the engagement state and a stable engagement between a first and second connector.

Conventional board-to-board connectors have been used for electrically connecting a pair of parallel circuit boards. Such connectors are attached, by fitting, to respective opposing surfaces of the pair of circuit boards so that they are electrically connected to each other. Moreover, a technique has already been proposed in which reinforcing brackets attached to both ends of a board-to-board connector are configured to function as a locking member so that a state of being engaged with a counterpart connector is maintained. An example of a typical board-to-board connector is disclosed in Japanese Patent Application No. 2004-55306.

FIG. 8 is a perspective view of reinforcing brackets of a conventional board-to-board connector. Referring to FIG. 8B, a first housing designated by reference numeral 811 is a housing of a first connector mounted in a non-illustrated, first circuit board, and referring to FIG. 8A, a second housing designated by reference numeral 911 is a housing of a second connector mounted in a non-illustrated, second circuit board. A plurality of non-illustrated first terminals is mounted in the first housing 811, and a plurality of non-illustrated second terminals is mounted in the second housing 911. When the first connector and the second connector are engaged together by fitting, corresponding ones of the first terminals and the second terminals are brought into contact with each other, so that the first circuit board and the second circuit board are electrically connected to each other.

Furthermore, first bracket accommodation-concave portions 826 having a groove shape are formed on both end portions in the longitudinal direction of the first housing 811, and first reinforcing brackets 851 are attached to the first housing 811 by being press-fitted into the first bracket accommodation-concave portions 826. The first reinforcing brackets 851 are an integral member formed by applying processing, e.g., punching and bending, to a metal plate. Each of the first reinforcing brackets 851 is provided with a body portion 852, fixing leg portions 856 which are extended downwardly from both ends of the body portion 852 to be soldered to the first circuit board, a pair of projection pieces 857 which are extended downwardly from the body portion 852, an elastic piece 853 which is formed between the projection pieces 857, and a locking projection 854 which projects outwardly from an inner surface of the elastic piece 853.

Similarly, second reinforcing brackets 951 are attached to the left and right sides of each of both ends in the longitudinal direction of the second housing 911. The second reinforcing brackets 951 are an integral member formed by applying processing, e.g., punching and bending, to a metal plate. Each of the second reinforcing brackets 951 is provided with a body portion 952, fixing leg portions 956 which are extended downwardly from both ends of the body portion 952 to be

soldered to the second circuit board, and a locking projection 954 which projects outwardly from the body portion 952.

When the first connector and the second connector are engaged together by fitting, the locking projections 854 of the first reinforcing brackets 851 are engaged with the locking projections 954 of the second reinforcing brackets 951. In this way, the first connector and the second connector are locked and their engagement state is maintained. When the first connector and the second connector are engaged together by fitting, either one of the first housing 811 and the second housing 911 is engaged with the other housing in a reversed position (upside down) from the illustrated position.

However, in the above-mentioned conventional board-to-board connector, since the first reinforcing brackets 851 and/or the second reinforcing brackets 951 are deformed elastically, it is difficult to lock the first connector and the second connector together with a sufficiently strong force even when the locking projections 854 of the first reinforcing brackets 851 are engaged with the locking projections 954 of the second reinforcing brackets 951. That is to say, when a removal force which is a force that releases the engagement between the first connector and the second connector is applied to the first connector and/or the second connector, the body portion 852 of each of the first reinforcing brackets 851 and/or the body portion 952 of each of the second reinforcing brackets 951 is torsionally deformed. Thus, the engagement between the locking projections 854 of the first reinforcing brackets 851 and the locking projections 954 of the second reinforcing brackets 951 is easily released. Particularly, in the case of the first reinforcing brackets 851, since the span between the leg portions 856 formed at both ends of the body portion 852 is large, the amount of torsional deformation at the center of the body portion 852 becomes large. As a result, the amount of displacement of the locking projections 854 increases, so that the locking projections 854 are easily separated from the locking projections 954 of the second reinforcing brackets 951.

## SUMMARY OF THE PRESENT APPLICATION

Therefore, it is an object of the Present Application to obviate the above-described problems encountered by the conventional board-to-board connector and to provide a board-to-board connector having such a configuration that at least one of first reinforcing brackets of a first connector and second reinforcing brackets of a second connector is provided with a bent portion having a crank shape as viewed from an insertion/removal direction of the first and second connectors, so that deformation of the first reinforcing brackets and/or the second reinforcing brackets can be prevented, and a firm engagement state between the first reinforcing brackets and the second reinforcing brackets is achieved. As a result, a strong removal force is required for releasing the engagement state, and a stable engagement between the first connector and the second connector can be maintained. Accordingly, it is possible to provide good operability and high reliability for the board-to-board connector.

Therefore, in accordance with the Present Application, a board-to-board connector is provided which comprises: a first connector having first terminals, a first housing which has a generally rectangular parallelepiped shape and is provided with concave insertion portions, and first reinforcing brackets which are arranged in the concave insertion portions; and a second connector having second terminals configured to make contact with the first terminals, a second housing which has a generally rectangular parallelepiped shape and is provided with convex insertion portions configured to be inserted

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in the concave insertion portions, and second reinforcing brackets which are arranged in the convex insertion portions and configured to be engaged with the first reinforcing brackets, wherein at least one of the first reinforcing brackets and the second reinforcing brackets is provided with a bent portion having a crank shape as viewed from an insertion/removal direction of the first and second connectors.

In accordance with another aspect of the Present Application, the board-to-board connector has such a configuration that each of the first reinforcing brackets is provided with a strip-shaped first body portion which is configured to extend in a width direction of the first housing and a first locking portion which is formed on the first body portion; each of the second reinforcing brackets is provided with a strip-shaped second body portion, which is configured to extend in a width direction of the second housing, and a second locking portion which is formed on the second body portion and which is configured to be engaged with the first locking portion; and one of the first locking portion and the second locking portion is a convex portion, and the other one is a concave portion or an opening portion.

In accordance with a further aspect of the Present Application, the board-to-board connector has such a configuration that the first and second locking portions are provided plural in number, respectively, and at least two of them are arranged horizontally symmetrically.

In accordance with a still further aspect of the Present Application, the board-to-board connector has such a configuration that each of the first reinforcing brackets is provided with first arm portions which are connected to both ends of the first body portion and configured to extend in the longitudinal direction of the first housing to be held in the first housing; and each of the second reinforcing brackets is provided with second arm portions which are connected to both ends of the second body portion and configured to extend in the longitudinal direction of the second housing to be held in the second housing.

In accordance with a still further aspect of the Present Application, the board-to-board connector has such a configuration that the first body portion is provided with a central portion formed with the first locking portion and configured to extend in a straight-line shape along the width direction of the first housing as viewed from the insertion/removal direction; a pair of the bent portions are connected to both ends of the central portion; and a pair of outer end portions are configured to extend in the width direction of the first housing from the bent portions.

In accordance with a still further aspect of the Present Application, the board-to-board connector has such a configuration that the concave insertion portions are formed at both ends in the longitudinal direction of the first housing; the first reinforcing brackets are arranged near the outer ends of each concave insertion portion; the convex insertion portions are formed at both ends in the longitudinal direction of the second housing; and the second reinforcing brackets are arranged along the outer ends in the longitudinal direction of each convex insertion portion.

In accordance with the Present Application, the board-to-board connector has such a configuration that at least one of the first reinforcing brackets of the first connector and the second reinforcing brackets of the second connector is provided with the bent portion having a crank shape as viewed from the insertion/removal direction of the first and second connectors. Owing to such a configuration, deformation of the first reinforcing brackets and/or the second reinforcing brackets can be prevented, and a firm engagement state between the first reinforcing brackets and the second rein-

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forcing brackets is achieved. As a result, a strong removal force is required for releasing the engagement state, and a stable engagement between the first connector and the second connector can be maintained. Accordingly, the board-to-board connector has good operability and high reliability.

#### BRIEF DESCRIPTION OF THE FIGURES

The organization and manner of the structure and operation of the Present Application, together with further objects and advantages thereof, may best be understood by reference to the following Detailed Description, taken in connection with the accompanying Figures, wherein like reference numerals identify like elements, and in which:

FIG. 1 is an exploded view of a first connector of a board-to-board connector according to the Present Application, viewed from a fitting face thereof;

FIG. 2 is a perspective view of first and second connectors of the board-to-board connector according to the Present Application, wherein the connectors are engaged together by fitting, viewed from a fitting face of the first connector;

FIG. 3 is a perspective view of the first connector, viewed from a fitting face thereof;

FIG. 4 is an exploded view of the second connector, viewed from a fitting face thereof;

FIG. 5 is a perspective view of the second connector, viewed from a fitting face thereof;

FIGS. 6A and 6B are first cross-sectional views of the reinforcing brackets of the connectors, taken along Arrows A-A in FIG. 2, in which FIG. 6A illustrates a normal state, and FIG. 6B illustrates where a removal force is applied thereto;

FIGS. 7A and 7B are second cross-sectional views of the reinforcing brackets of the connectors, taken along Arrows B-B in FIG. 2, in which FIG. 7A illustrates a normal state, and FIG. 7B illustrates where a removal force is applied thereto; and

FIG. 8 is a perspective view of a conventional board-to-board connector.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

While the Present Application may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the disclosure is to be considered an exemplification of the principles of the Present Application, and is not intended to limit the Present Application to that as illustrated.

In the illustrated embodiments, directional representations—i.e., up, down, left, right, front, rear and the like, used for explaining the structure and movement of the various elements of the Present Application, are relative. These representations are appropriate when the elements are in the position shown in the Figures. If the description of the position of the elements changes, however, it is assumed that these representations are to be changed accordingly.

In the drawing figures, a first connector, as one of a pair of board-to-board connectors according to the present embodiment, generally designated by reference numeral 1, is a surface-mounted type connector, which is mounted on a surface of a non-illustrated first board. Moreover, a second connector, as the other one of the pair of board-to-board connectors according to the present embodiment, generally designated by reference numeral 101, is a surface-mounted type connector, which is mounted on a surface of a non-illustrated second board. The board-to-board connector according to the present

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embodiment includes the first connector **1** and the second connector **101**, and is configured to electrically connect the first board and the second board with each other. Here, the first board and the second board are for example printed circuit boards, flexible flat cable, flexible printed circuit, and the like, used in an electronic device or apparatus, and may be any type of board.

The first connector **1** includes a first housing **11** as a connector body integrally formed of an insulating material. As will be understood from the drawing figures, the first housing **11** is a generally rectangular parallelepiped member having a generally rectangular, thick plate-like shape. A concave portion **12** having a generally rectangular shape having a surrounded perimeter is formed on a side, i.e., a fitting face side (the upper side in FIGS. 3), where the second connector **101** is fitted. The first connector **1** has a dimension of about 10.0 mm in length, about 2.5 mm in width, and about 1.0 mm in thickness, and the dimension may be appropriately changed. Moreover, a first protrusive convex portion **13** as an island portion is formed in the concave portion **12** to be integral with the first housing **11**. Furthermore, side wall portions **14** configured to extend in parallel to the first protrusive convex portion **13** are formed at both sides of the first protrusive convex portion **13** to be integral with the first housing **11**. In this case, the first protrusive convex portion **13** and the side wall portions **14** protrude upwardly from the bottom surface of the concave portion **12** and extend in the longitudinal direction of the first housing **11**. Owing to this configuration, recessed groove portions **12a**, as a portion of the concave portion **12**, being elongated concave portions configured to extend in the longitudinal direction of the first housing **11** are formed at both sides of the first protrusive convex portion **13** to be disposed between the first protrusive convex portion **13** and the side wall portions **14**. Although in the example illustrated, the first protrusive convex portion **13** is singular in number, a plurality of first protrusive convex portions **13** may be provided and the number thereof is not particularly limited. In addition, the first protrusive convex portion **13** has a dimension of about 0.6 mm in width, for example, the dimension may be appropriately changed.

In this embodiment, first terminal-receiving inside cavities **15a** having a recessed groove shape are formed on both side surfaces of the first protrusive convex portion **13**. Moreover, first terminal-receiving outside cavities **15b** having a recessed groove shape, respectively, are formed on inner side surface of the side wall portion **14**. Since the first terminal-receiving inside cavities **15a** and the first terminal-receiving outside cavities **15b** are connected with each other at a bottom surface of the recessed groove portion **12a** and are integral with each other, the first terminal-receiving inside cavities **15a** and the first terminal-receiving outside cavities **15b** will be collectively referred to as first terminal receiving cavities **15**.

The number of first terminal receiving cavities **15** on each side of the first protrusive convex portion **13** is 8, with a pitch of about 0.4 mm, for example. Moreover, the number of first terminals **61** received in the first terminal receiving cavities **15** on each side of the first protrusive convex portion **13**, is 8 with a pitch of about 0.4 mm, for example. It should be appreciated that the pitch and the number of first terminal receiving cavities **15** may be appropriately changed.

The first terminals **61** are an integral member formed, by applying e.g., punching and bending to a conductive metallic plate. Each of the first terminals **61** is provided with a holding portion **63**, a tail portion **62** connected to a lower end of the holding portion **63**, an upper connection portion **67** connected to an upper end of the holding portion **63**, a second contact portion **66** formed in the vicinity of an inner end of the upper

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connection portion **67**, a lower connection portion **64** connected to the second contact portion **66**, and a first contact portion **65** formed in the vicinity of a free end of the lower connection portion **64**.

The holding portions **63** are portions that extend in the up-down direction, i.e., in the thickness direction of the first housing **11** to be held by being fitted in the first terminal-receiving outside cavities **15b**. The tail portions **62** are bent to be connected to the holding portions **63** and extend in the left-right direction, i.e., outwardly in the width direction of the first housing **11** to be connected to connection pads connected to a conductive trace on the first board by means of soldering or the like. The upper connection portions **67** are bent to be connected to the holding portions **63** and extend inwardly in the width direction of the first housing **11**.

The second contact portions **66**, having a curved shape, configured to downwardly bend and protrude toward the inner side in the width direction of the first housing **11**, are formed at the inner ends of the upper connection portions **67**. The lower connection portions **64** have a general U-shape in side view and are connected to the lower ends of the second contact portions **66**. Furthermore, the first contact portions **65** having a curved shape and configured to bend in an U shape and outwardly protrude in the width direction of the first housing **11** are formed at the free ends, i.e., in the vicinity of the inner upper ends of the lower connection portions **64**.

The first terminals **61** are fitted into the first terminal receiving cavities **15** from the mounting side (the lower side in FIG. 3) to be fixedly secured to the first housing **11** when the holding portions **63** are clamped by the side walls of the first terminal-receiving outside cavities **15b** in a sandwich manner, which are formed side surface of inside the side wall portions **14**. In this state, that is, a state where the first terminals **61** are mounted in the first housing **11**, the first contact portions **65** and the second contact portions **66** are positioned on both left and right sides of the recessed groove portion **12a** so as to oppose each other.

Since the first terminals **61** are integrally formed by applying processing to a metal plate, they have some degree of elasticity. As is obvious from the shape of the first terminals, the gap between the opposing first contact portions **65** and the second contact portions **66** is elastically changeable. Thus, when the second terminals **161** of the second connector **101** are inserted to be positioned between the first contact portions **65** and the second contact portions **66**, the gap between the first contact portions **65** and the second contact portions **66** is elastically increased.

Furthermore, first protrusive end portions **21** are arranged at both ends in the longitudinal direction of the first housing **11**, respectively. A concave protrusive end portion **22** of the concave portion **12** is formed in each of the first protrusive end portions **21**. The concave protrusive end portions **22** are generally rectangular concave portions and are connected to both ends in the longitudinal direction of each of the recessed groove portions **12a**. Moreover, the concave protrusive end portion **22** functions as a concave insertion portion in which a later-described second protrusive end portion **122** of the second connector **101** is inserted in a state where the first connector **1** and the second connector **101** are engaged by fitting together.

Each of the first protrusive end portions **21** is provided with sidewall extension portions **21b** configured to extend in the longitudinal direction of the first housing **11** from both ends in the longitudinal direction of the side wall portion **14** and an end wall portion **21c** configured to extend in the short-axis direction of the first housing **11** and having both ends thereof connected to the sidewall extension portions **21b**. In each of

the first protrusive end portions **21**, the end wall portion **21c** and the sidewall extension portions **21b** connected to both ends of the end wall portion **21c** form a continuous side wall having an inverted C shape to thereby define three sides of the rectangular concave protrusive end portion **22**.

Furthermore, first reinforcing brackets **51** are attached to the first protrusive end portions **21**. The first reinforcing brackets **51** are arranged at the vicinity of the outer ends in longitudinal direction of the first housing **11** of the concave protrusive end portion **22**, and are received and held in first concave bracket holding portions **26** formed in the sidewall extension portions **21b**.

In the illustrated example, the first reinforcing brackets **51** are integrally formed by applying processing, e.g., punching and bending, to a metal plate. Each of the first reinforcing brackets **51** is provided with a first body portion **52** which generally has an elongated strip shape and is configured to extend in the width direction of the first housing **11**, first arm portions **57** which are configured to bend to be connected to both left and right ends of the first body portion **52** and extend in the longitudinal direction of the first housing **11** to be held in the first housing **11**, a first board connection portion **56** which is connected to a lower end of each of the first arm portions **57**, and the first locking portions **54** which are formed in the first body portion **52**.

The first body portion **52** is provided with a central portion **52a** configured to extend in a straight-line shape along the width direction of the first housing **11** as viewed from the insertion/removal direction of the first and second connectors **1** and **101**, namely the vertical direction, bent portions **52b** which are configured to bend in a crank shape as viewed from the vertical direction to be connected to both ends of the central portion **52a**; and outer end portions **52c** configured to extend in a straight-line shape along the width direction of the first housing **11** and extend in the width direction of the first housing **11** from the bent portions **52b**. Moreover, in the example illustrated in the drawing figure, the bent portions **52b** are bent so that the central portion **52a** is positioned closer to the center in the longitudinal direction of the first housing **11** than the outer end portions **52c**. However, the outer end portions **52c** may be positioned closer to the center in the longitudinal direction of the first housing **11** than the central portion **52a**.

Furthermore, although in the example illustrated, a pair of first locking portions **54** is formed in the central portion **52a**, the number of first locking portions **54** may be single and may be three or more, and the number thereof is not particularly limited. In addition, although the positions of the first locking portions **54** can be determined arbitrarily, they are typically arranged horizontally symmetrically with respect to the central axis in the width direction of the first housing **11**. That is to say, when the number of first locking portions **54** is odd, one of them is positioned on the central axis in the width direction of the first housing **11** and the remaining halves are equally arranged on the left and right sides so that they are horizontally symmetrical with respect to the central axis. When the number of first locking portions **54** is even, they are equally arranged on the left and right sides so that they are horizontally symmetrical with respect to the central axis. In addition, although in the example illustrated in the drawing figure, the first locking portions **54** are convex portions configured to protrude outwardly from the surface of the central portion **52a**, they are not necessarily convex portions as long as they have such a shape that they can be engaged with later-described second locking portions **154**. For example, when the second locking portions **154** are convex portions, the first locking portions **54** may be concave or opening

portions capable of being engaged with the convex portions. However, in the present embodiment, for the sake of explanation, description will be made for the case where the first locking portions **54** are a pair of convex portions and arranged horizontally symmetrically with respect to the central axis in the width direction of the first housing **11**.

Each of the first arm portions **57** is configured to extend from an outer end of each of the outer end portions **52c** toward the center in the longitudinal direction of the first housing **11** and is provided with a first concave and convex lock-latching portion **57a** at a free end thereof. Furthermore, the first board connection portions **56** are connected to the lower ends of the first arm portions **57** so that a free end of each of the first board connection portions **56** is bent outwardly in the width direction of the first housing **11**. The first board connection portions **56** function as solder tail portions of the first reinforcing brackets **51**, and lower surfaces thereof are formed to be substantially parallel with a non-illustrated mounting surface of the first housing **11** and are fixedly secured to fixing pads on the first board by means of soldering or the like.

Each of the first concave bracket holding portions **26** is provided with groove-shaped outer end portion-receipt portions **26a** configured to extend in the thickness and width directions of the first housing **11**, first groove-shaped arm portion-receipt portion **26b** configured to extend in the thickness and longitudinal directions of the first housing **11** and formed in the sidewall extension portions **21b** to be connected to the outer end portion-receipt portion **26a**, first lock-latched portions **26c** arranged at the end portions of the first arm portion-receipt portions **26b**, close to the center in the longitudinal direction of the first housing **11** and configured to be latched by the first lock-latching portions **57a**, and connection portion-receipt opening portions **26d** configured to be connected to the first arm portion-receipt portions **26b** and opened to the outer surfaces of the sidewall extension portions **21b** so that the first board connection portions **56** can be seen from the outside.

In a state where the first reinforcing brackets **51** are attached to the first protrusive end portions **21**, almost the entire bodies thereof are received in the first concave bracket holding portions **26**. However, a surface of the central portion **52a** of the first body portion **52** at the center in the longitudinal direction of the first housing **11** is exposed to the concaved protrusive end portions **22** together with the first locking portions **54**. Moreover, the first board connection portions **56** and outer side surfaces of the first arm portions **57** located above the first board connection portions **56** are exposed to the connection portion-receipt opening portions **26d**.

The second connector **101** includes a second housing **111** as a connector body integrally formed of an insulating material such as synthetic resin. As will be understood from the drawing figure, the second housing **111** is a generally rectangular parallelepiped member having a generally rectangular, thick plate-like shape. The second housing **111** has a dimension of about 8.0 mm in length, about 1.5 mm in width, and about 0.8 mm in thickness, and the dimension may be appropriately changed as required. Moreover, an elongated recessed cavity portion **113** configured to extend in the longitudinal direction of the second housing **111** and second protrusive convex portions **112** as an elongated protrusive convex portion configured to define the outer sides of the recessed cavity portion **113** and extend in the longitudinal direction of the second housing **111** are integrally formed on a side, i.e., a fitting face side (the upper side in FIGS. 4 and 5) of the second housing **111** where the first connector **1** is fitted. The second protrusive convex portions **112** are formed along both sides of the recessed cavity portion **113** and along both

sides of the second housing **111**. Moreover, second terminals **161** as a terminal are arranged in each of the second protrusive convex portions **112**.

As illustrated in the drawing figure, the recessed cavity portion **113** is closed by a bottom portion at a surface thereof on a side, i.e., a mounting surface (the lower surface in FIGS. **4** and **5**) where it is mounted on the second board. Moreover, although in the example illustrated in the drawing figure, the number of second protrusive convex portions **112** is two, it may be singular in number and the number thereof is not particularly limited. The recessed cavity portion **113** has a dimension of about 0.7 mm in width, for example, and the dimension thereof may be appropriately changed as required.

The second terminals **161** are an integral member formed by applying processing, e.g., punching and bending to a conductive metal plate. Each of the second terminals **161** is provided with a non-illustrated body portion, a tail portion **162** connected to a lower end of the body portion, a first contact portion **165** connected to an upper end of the body portion, a connection portion **164** connected to an upper end of the first contact portion **165**, and a second contact portion **166** connected to an outer end of the connection portion **164**. Moreover, first concave contact portions **165a** configured to be engaged with the first contact portions **65** of the first terminals **61** are formed on the surface of the first contact portions **165**, and second concave contact portions **166a** configured to be engaged with the second contact portions **66** of the first terminals **61** are formed on the surface of the second contact portions **166**.

The body portion is a portion which is held in a state where a perimeter thereof is surrounded by the second housing **111** and is not illustrated in FIGS. **4** and **5**. Moreover, the tail portions **162** are connected to the lower ends of the second terminals **161** which extend in the horizontal direction of the body portion, namely the width direction of the second housing **111**, and are extended outwardly from the second housing **111** to be connected to connection pads connected to a conductive trace on the second board by means of soldering or the like. The first contact portions **165** are flat plate-like portions that are connected to the body portions so as to extend in the vertical direction, namely in the thickness direction of the second housing **111**. The connection portions **164** are bent to be connected to the first contact portions **165** and extend outwardly in the width direction of the second housing **111**. The second contact portions **166** are portions that are bent downwardly to be connected to the outer ends of the connection portions **164** so as to extend downwardly.

The second terminals **161** are integrated with the second housing **111** by means of over-molding. That is to say, the second housing **111** is formed by filling resin in a cavity of a mold having the second terminals **161** being set therein. In this way, the second terminals **161** are integrally attached to the second housing **111** in a state where the body portions are buried in the second housing **111**, and the surfaces of the first contact portions **165** and the connection portions **164**, and the second contact portions **166** are exposed to the respective lateral surfaces of the second convex portions **112** and the fitting surfaces. In this case, the number of second terminals **161** arranged in the second housing **111** is 16 with a pitch of about 0.4 mm, for example. Moreover, the pitch and the number of the second terminals **161** are appropriately changed.

Furthermore, second protrusive end portions **122** as a second fitting guide portion are arranged at both ends in the longitudinal direction of the second housing **111**, respectively. Each of the second protrusive end portions **122** is a thick member that extends in the width direction of the second

housing **111** and has both ends thereof connected to both ends in the longitudinal direction of the second protrusive convex portion **112**, and an upper surface thereof has a generally rectangular shape. Moreover, the second protrusive end portions **122** function as convex insertion portions which are inserted in the concave protrusive end portions **22** of the first protrusive end portions **21** of the first connector **1** in a state where the first connector **1** and the second connector **101** are engaged by fitting together.

Furthermore, second reinforcing brackets **151** as a reinforcing bracket are attached to the second protrusive end portions **122**. The second reinforcing brackets **151** are arranged along the outer ends in the longitudinal direction of the second housing **111** of the second protrusive end portion **122**, and are received and held in second concave bracket holding portions **126** formed in the second protrusive end portion **122**.

In the present embodiment, the second reinforcing brackets **151** are an integral member formed by applying processing, e.g., punching and bending, to a metal plate. Each of the second reinforcing brackets **151** is provided with a second body portion **152** which generally has an elongated strip shape and is configured to extend in the width direction of the second housing **111**, second arm portions **157** which are configured to bend to be connected to both left and right ends of the second body portion **152** and extend in the longitudinal direction of the second housing **111** to be held in the second housing **111**, a second board connection portion **156** which is connected to a lower end of each of the second arm portions **157**, and second locking portions **154** which are formed in the second body portion **152**.

Although in the example illustrated in the drawing figure, a pair of second locking portions **154** is formed in the second body portion **152**, the number of second locking portions **154** may be single and may be three or more, and the number thereof is not particularly limited but is set so as to correspond to the number of first locking portions **54** of the first reinforcing brackets **51**. Furthermore, the arrangement of the second locking portions **154** is set so as to correspond to the arrangement of the first locking portions **54**, and they are typically arranged horizontally symmetrically with respect to the central axis in the width direction of the second housing **111**. In addition, although in the example illustrated in the drawing figure, the second locking portions **154** are opening portions that penetrate through the second body portion **152** in the thickness direction, the second locking portions **154** may be concave portions configured to be depressed from the surface of the second body portion **152** but are not necessarily opening portions as long as they have a shape capable of being engaged with the first locking portions **54**. For example, when the first locking portions **54** are concave or opening portions, the second locking portions **154** may be convex portions configured to be capable of being engaged with the concave or opening portions. However, in the present embodiment, for the sake of explanation, description will be made of the case where the second locking portions **154** are a pair of opening portions and arranged horizontally symmetrically with respect to the central axis in the width direction of the second housing **111**.

Each of the second arm portions **157** is configured to extend from either left or right end of each of the second body portion **152** toward the center in the longitudinal direction of the second housing **111** and is provided with a second locking-latching portion **157a** at a free end thereof, which is configured to protrude upwardly. Furthermore, the second board connection portions **156** are connected to the lower ends of the second arm portions **157** so that a free end of each of the

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second board connection portions **156** is bent outwardly in the width direction of the second housing **111**. The second board connection portions **156** function as solder tail portions of the second reinforcing brackets **151**, and lower surfaces thereof are formed to be substantially parallel with a non-illustrated mounting surface of the second housing **111** and are fixedly secured to fixing pads on the second board by means of soldering or the like.

Each of the second concave bracket holding portions **126** is provided with second body portion-receipt portion **126a** which are outer side surfaces of the second protrusive end portions **122** in the longitudinal direction of the second housing **111** and configured to extend in the thickness and width directions of the second housing **111**, second groove-shaped arm portion-receipt portion **126b** configured to extend in the thickness and longitudinal directions of the second housing **111** so as to be connected to both ends of each of the second body portion-receipt portions **126a**, and second lock-latched portions **126c** which are arranged at the end portions of the second arm portion-receipt portions **126b**, close to the center in the longitudinal direction of the second housing **111** so as to extend in the vertical direction, and which have upper ends thereof being opened to the surfaces of the second protrusive end portions **122** and are configured to be latched by the second lock-latching portions **157a**.

In a state where the second reinforcing brackets **151** are attached to the second protrusive end portions **122**, almost the entire bodies thereof are received in the second concave bracket holding portions **126**. However, a surface of the second body portion **152** at the outside in the longitudinal direction of the second housing **111** is exposed to surfaces of the second protrusive end portions **122** at the outside in the longitudinal direction of the second housing **111** together with the second locking portions **154**. Moreover, the lower surfaces of the second board connection portions **156** are exposed to the mounting surface of the second housing **111**. On the other hand, in a state where the first connector **1** and the second connector **101** are engaged by fitting together, the second locking portion **154** is engaged with the first locking portion **54** of each of the first reinforcing brackets **51** of the first connector **1**.

In this embodiment, the first connector **1** is assumed to be surface-mounted on the first board in a state where the tail portions **62** of the first terminals **61** are connected to a non-illustrated connection pads connected to a conductive trace on the first board by means of soldering or the like and the first board connection portions **56** of the first reinforcing brackets **51** are connected to the fixing pads on the first board by means of soldering or the like.

Similarly, the second connector **101** is assumed to be surface-mounted on the second board in a state where the tail portions **162** of the second terminals **161** are connected to the non-illustrated connection pads connected to a conductive trace on the second board by means of soldering or the like and the second board connection portions **156** of the second reinforcing brackets **151** are connected to the fixing pads on the second board by means of soldering or the like.

First, the operator manipulates the connectors so that the fitting face of the first connector **1** opposes the fitting face of the second connector **101**. When the positions of the second protrusive convex portions **112** on the left and right sides of the second connector **101** correspond to the positions of the recessed groove portions **12a** on the left and right sides of the first connector **1**, the positioning between the first connector **1** and the second connector **101** is completed.

In such a state, when the operator moves the first connector **1** and/or the second connector **101** in a direction toward either

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one of the connectors, i.e., in the fitting direction, the second protrusive convex portions **112** on the left and right sides of the second connector **101** are received in the recessed groove portions **12a** on the left and right sides of the first connector **1**. Moreover, the second terminals **161** of the second connector **101** are positioned between the first contact portions **65** and the second contact portions **66** of the first terminals **61**, so that the first contact portions **65** of the first terminals **61** contact the first contact portions **165** of the second terminals **161**, and the second contact portions **66** of the first terminals **61** are brought into contact with the second contact portions **163** of the second terminals **161**.

In this way, as illustrated in FIG. 2, when the fitting engagement between the first connector **1** and the second connector **101** is completed, the first terminals **61** and the second terminals **161** are electrically connected to each other. Specifically, the first contact portions **65** of the first terminals **61** are engaged with the first concave contact portions **165a** of the second terminals **161**, and the second contact portions **66** of the first terminals **61** are engaged with the second concave contact portion **166a** of the second terminals **161**. As a result, the conductive trace connected to the connection pads on the first board being connected to the tail portions **62** of the first terminals **61** are electrically connected to the conductive trace connected to the connection pads on the second board being connected to the tail portions **162** of the second terminals **161**. In this case, since the first terminals **61** and the second terminals **161** make multi-point contact with each other, it is possible to certainly maintain stable electrical connection.

Moreover, as illustrated in FIGS. 6 and 7, the first reinforcing brackets **51** of the first connector **1** and the second reinforcing brackets **151** of the second connector **101** are locked by being engaged with each other. In this case, the first locking portions **54** of the first reinforcing brackets **51**, which are convex portions, are inserted in the second locking portions **154** of the second reinforcing brackets **151**, which are opening portions, and the first locking portions **54** are engaged with the second locking portions **154**, whereby the first connector **1** and the second connector **101** are locked.

Therefore, it is difficult to remove the second connector **101** from the first connector **1** even upon receipt of a force that releases the fitting engagement between the first connector **1** and the second connector **101**, that is, upon receipt of a removal force for removing the second connector **101** from the first connector **1**. That is, a necessary removal force is increased.

Here, when the states of the first reinforcing bracket **51** and the second reinforcing bracket **151** upon receipt of a removal force are observed closely, it can be understood from FIG. 6B that the first body portion **52** of the first reinforcing bracket **51** is torsionally deformed. As will be obvious from comparison with FIG. 6A, this is because upon receipt of the removal force, the second reinforcing bracket **151** is raised relative to the first reinforcing bracket **51**, so that the first locking portion **54**, engaged with the second locking portion **154**, receives a force that displaces the first locking portion **54** upwardly. Thus, the first body portion **52** receives a torsional moment.

When the removal force is large, the amount of torsional deformation of the first body portion **52** becomes large, and the engagement between the first locking portion **54** and the second locking portion **154** is released. As a result, the lock between the first connector **1** and the second connector **101** is released, and thus the engagement between the first connector **1** and the second connector **101** may be released.

However, in the present embodiment, the first body portion **52** is provided with the bent portion **52b** that bends in a crank shape as viewed from the insertion/removal direction of the

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first and second connectors **1** and **101**. More specifically, crank-shaped bent portions **52b** are connected to both sides of the central portion **52a** on which the first locking portions **54** are formed. Owing to such a configuration, the first body portion **52** has a high section modulus and a high torsional rigidity and is scarcely torsionally deformed. Therefore, even when the first body portion **52** receives a torsional moment, since the amount of torsional deformation of the first body portion **52** is small, the engagement between the first locking portion **54** and the second locking portion **154** is not released. That is to say, since the first body portion **52** has a high torsional rigidity due to the crank-shaped bent portion **52b**, a necessary removal force is large and it is thus difficult to remove the second connector **101** from the first connector **1**.

Furthermore, in the present embodiment, the first body portion **52** is provided with the pair of first locking portions **54** which are arranged on left and right sides thereof. Owing to such a configuration, the first left and right locking portions **54** are positioned close to the left and right bent portions **52b** which have a high torsional rigidity. Therefore, even upon receipt of a force from the second locking portion **154**, since the amount of upward displacement of the first locking portion **54** is small, the engagement between the first locking portion **54** and the second locking portion **154** is not released. That is to say, since the first locking portion **54** is positioned close to the crank-shaped bent portion **52b**, a necessary removal force is further increased, and it becomes further difficult to remove the second connector **101** from the first connector **1**. When the number of first locking portions **54** is three or more, the force applied to each of the first locking portions **54** will be decreased further, and it becomes further difficult to remove the second connector **101** from the first connector **1**.

The second body portion **152** of the second reinforcing bracket **151** receives a torsional moment similar to the first body portion **52** of the first reinforcing bracket **51**. However, the dimension of the second body portion **152** in the width direction of the second housing **111** is extremely small compared to the first body portion **52**. Therefore, the amount of torsional deformation of the second body portion **152** is supposed to be small even upon receipt of a torsional moment of the same magnitude. Thus, in the present embodiment, the same crank-shaped portion as the bent portion **52b** is not formed in the second body portion **152**. Nevertheless, when it is necessary to decrease further the amount of torsional deformation of the second body portion **152**, the same crank-shaped bent portion as the bent portion **52b** may be formed in the second body portion **152**.

Furthermore, under practical use condition, the direction of the removal force may be oblique to the insertion/removal direction of the first and second connectors **1** and **101**. That is, an oblique removal force may be applied. Here, when the states of the first reinforcing bracket **51** and the second reinforcing bracket **151** upon receipt of an oblique removal force are observed closely, it can be understood from FIG. 7B, the second body portion **152** of the second reinforcing bracket **151** is sloped with respect to the first body portion **52** of the first reinforcing bracket **51**. As will be obvious from comparison with FIG. 7A, upon receipt of a removal force, one end (the left end) in the width direction of the second body portion **152** is raised relative to the first body portion **52**. That is to say, a rotational moment acts on the second body portion **152** in a direction (clockwise direction in the example illustrated in the drawing figure) of rotating the second body portion **152** about an axis perpendicular to the drawing sheet and extending along the center in the width direction of the second body portion **152**.

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As described above, when an oblique removal force is applied, a force caused by the rotational moment is applied to the first locking portion **54** and the second locking portion **154** in addition to the above-mentioned force that raises the second reinforcing bracket **151** relative to the first reinforcing bracket **51**. Thus, it becomes easy to release the engagement between the first locking portion **54** and the second locking portion **154**.

However, in the present embodiment, the first body portion **52** and the second body portion **152** are respectively provided with the pair of first locking portions **54** and the pair of second locking portions **154** which are arranged on the left and right sides, respectively. Owing to such a configuration, the first locking portions **54** and the second locking portions **154** are arranged at positions separated from the central axis of the rotational moment. Therefore, an upward urging force caused by the rotational moment applied to the first locking portion **54** at one end (the left end in the example illustrated in the drawing figure) in the width direction is small, and thus the engagement between the first locking portion **54** and the second locking portion **154** is not released. That is to say, since the first locking portion **54** and the second locking portion **154** are separated from the center in the width direction, the influence of the force caused by the rotational moment is decreased even upon receipt of the oblique removal force, and it is thus difficult to remove the second connector **101** from the first connector **1**. When the numbers of first locking portions **54** and second locking portions **154** are respectively three or more, the force applied to each of the first locking portions **54** will be decreased further, and it becomes further difficult to remove the second connector **101** from the first connector **1**.

The first reinforcing brackets **51** and the second reinforcing brackets **151** can be used as ground terminals. In this case, the first board connection portions **56** of the first reinforcing brackets **51** are connected to connection pads, which are connected to the ground line on the first board, by means of soldering or the like, and the second board connection portions **156** of the second reinforcing brackets **151** are connected to connection pads, which are connected to the ground line on the second board, by means of soldering or the like.

As described above, in the present embodiment, at least one of the first reinforcing brackets **51** and the second reinforcing brackets **151** is provided with the bent portion **52b** having a crank shape as viewed from the insertion/removal direction of the first and second connectors **1** and **101**. Owing to such a configuration, deformation of the first reinforcing brackets **51** and/or the second reinforcing brackets **151** is prevented, and a firm engagement state between the first reinforcing brackets **51** and the second reinforcing brackets **151** can be achieved. As a result, a strong removal force is required for releasing the engagement state, and a stable engagement between the first connector **1** and the second connector **101** can be maintained. Accordingly, it is possible to provide good operability and high reliability for the board-to-board connector.

Moreover, each first reinforcing bracket **51** is provided with the first strip-shaped body portion **52**, configured to extend in the width direction of the first housing **11** and the first locking portion **54** which is formed on the first body portion **52**. Each of the second reinforcing brackets **151** is provided with the second strip-shaped body portion **152**, which is configured to extend in the width direction of the second housing **111**, and the second locking portion **154** which is formed on the second body portion **152** and which is configured to be engaged with the first locking portion **54**. One of the first locking portion **54** and the second locking



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portion **154** is a convex portion, and the other one is a concave portion or an opening portion. Owing to such a configuration, the first locking portion **54** and the second locking portion **154** can be engaged firmly, and the first connector **1** and the second connector **101** can be locked firmly.

Furthermore, the first locking portion **54** and the second locking portion **154** are provided plural in number, respectively, and at least two of them are arranged horizontally symmetrical. Owing to such a configuration, even when an oblique removal force is applied, the influence of a force caused by a rotational moment is decreased, and a stable engagement between the first connector **1** and the second connector **101** can be maintained.

Furthermore, each of the first reinforcing brackets **51** is provided with the first arm portions **57** which are connected to both ends of the first body portion **52** and configured to extend in the longitudinal direction of the first housing **11** to be held in the first housing **11**. Each of the second reinforcing brackets **151** is provided with the second arm portions **157** which are connected to both ends of the second body portion **152** and configured to extend in the longitudinal direction of the second housing **111** to be held in the second housing **111**. Owing to such a configuration, the first reinforcing brackets **51** and the second reinforcing brackets **151** have an increased rigidity and are prevented from being deformed, and thus a firm engagement state between the first reinforcing brackets **51** and the second reinforcing brackets **151** can be achieved. Moreover, since the first reinforcing brackets **51** and the second reinforcing brackets **151** are firmly held in the first housing **11** and the second housing **111**, respectively, a stable engagement between the first connector **1** and the second connector **101** can be maintained.

Furthermore, the first body portion **52** is provided with the central portion **52a** which is formed with the first locking portion **54** and configured to extend in a straight-line shape along the width direction of the first housing **11** as viewed from the insertion/removal direction; the pair of bent portions **52b** which are connected to both ends of the central portion **52a**; and the pair of outer end portions **52c** which are configured to extend in the width direction of the first housing **11** from the bent portions **52b**. Owing to such a configuration, since the first body portion **52** has a high section modulus and a high torsional rigidity and is thus hardly torsionally deformed, the engagement between the first locking portion **54** and the second locking portion **154** is not released. Therefore, a stable engagement between the first locking portion **54** and the second locking portion **154** can be maintained, and a stable lock state between the first connector **1** and the second connector **101** can be achieved.

Furthermore, the concave insertion portions **22** are formed at both ends in the longitudinal direction of the first housing **11**; the first reinforcing brackets **51** are arranged at the vicinity of the outer ends of each concave insertion portion **22**; the second protrusive end portions **122** are formed at both ends in the longitudinal direction of the second housing **111**; and the second reinforcing brackets **151** are arranged along the outer ends in the longitudinal direction of each of the second protrusive end portions **122**. Owing to such a configuration, the first reinforcing brackets **51** and the second reinforcing brackets **151** are engaged together at both ends in the longitudinal direction of the first housing **11** and the second housing **111**, respectively, and the first reinforcing brackets **51** and the second reinforcing brackets **151** are entirely in a stable engagement state. As a result, a strong removal force is required for releasing the engagement state, and thus, a further stable engagement between the first connector **1** and the second connector **101** can be achieved.

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While a preferred embodiment of the Present Application is shown and described, it is envisioned that those skilled in the art may devise various modifications without departing from the spirit and scope of the foregoing Description and the appended Claims.

What is claimed is:

1. A board-to-board connector comprising:

a first connector, the first connector including first terminals, a first housing having a generally rectangular parallelepiped shape and concave insertion portions, and first reinforcing brackets disposed at opposite ends of the first housing and communicating with the concave insertion portions; and

a second connector, the second connector including second terminals configured to contact the first terminals, a second housing having a generally rectangular parallelepiped shape and convex insertion portions inserted into the concave insertion portions, and second reinforcing brackets arranged along the convex insertion portions and engaging the first reinforcing brackets when the first and second connectors are mated together;

wherein each of the first reinforcing brackets includes a body portion, the body portion including a central portion and a pair of outer end portions extending in a widthwise direction, the body portion further including a pair of bent portions extending at angles to the central and outer end portions and interconnecting the central and outer end portions together such that the central portion is longitudinally offset with respect to the outer end portions.

2. The board-to-board connector according to claim 1, wherein the first reinforcing bracket central and outer end portions are parallel.

3. The board-to-board connector according to claim 1, wherein each of the second reinforcing brackets includes a body portion extending in a widthwise direction and a pair of second arm portions extending longitudinally from opposite ends of the body portion.

4. The board-to-board connector according to claim 3, wherein the second reinforcing bracket body portion form part of the second housing convex insertion portions.

5. The board-to-board connector of claim 1, wherein each central portion includes a first locking portion disposed thereon.

6. The board-to-board connector according to claim 5, wherein the first reinforcing brackets each include a pair of arm portions extending longitudinally from the outer end portions and engaging the first housing.

7. The board-to-board connector according to claim 6, wherein the first reinforcing bracket arm portions include tail portions for attaching to a surface of a circuit board.

8. A board-to-board connector assembly, comprising:

a first connector, the first connector including an insulative housing supporting a plurality of conductive first terminals, the first connector housing having a generally rectangular parallelepiped shape and interior mating grooves, the first connector housing further including, at opposite ends thereof, first reinforcing brackets which communicate with some of the first connector housing mating grooves;

a second connector, mateable with the first connector, the second connector including an insulative housing supporting a plurality of conductive terminals, the second terminals configured to contact the first terminals when the first and second connectors are mated together, the second connector housing having a generally rectangular parallelepiped shape and projecting insertion por-

tions received in the first connector housing mating grooves when the first and second connectors are mated together, the second connector housing further including second reinforcing brackets forming parts of the projecting insertion portions and engaging the first reinforcing brackets when the first and second connectors are mated together; and

wherein each first reinforcing bracket includes a body portion, the body portion including a central portion and a pair of outer end portions extending widthwise of the first connector housing, the first reinforcing bracket body portion further including a pair of bent portions extending at angles to the central and outer end portions and interconnecting the central and outer end portions together such that the central portion is longitudinally offset with respect to the outer end portions.

9. The board-to-board connector assembly of claim 8, wherein the first reinforcing bracket central portions form parts of the first connector housing mating grooves.

10. The board-to-board connector assembly of claim 8, wherein the first reinforcing bracket central portions are disposed on the first connector housing inwardly of the outer end portions.

11. The board-to-board connector assembly of claim 8, wherein the first connector housing mating grooves communicate with each other to define a continuous mating groove.

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